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ABSTRACT

During the 1989-90 school year, Tennessee established Project Challenge in 17 of Tennessee's poor and educationally low-performing counties. The program applied the results of Project STAR, a longitudinal experiment causally linking class size to student achievement. This paper presents findings of a study that evaluated Project Challenge by analyzing the statewide rankings of the 17 participating systems. Reduced class sizes, with a 1:15 teacher/student ratio, showed positive results on reading and mathematics achievement in the Challenge counties. Mean ranks, calculated from second graders' Tennessee Comprehensive Assessment Program (TCAP) scores, improved from 99 for reading and 85 for math in 1992 to ranks of 79 and 57, respectively, in 1993. Tennessee has 138 systems, so a rank of 69 is average. In 1990, Challenge systems as a group were below average; by 1993, they were above average in math and 20 ranks closer to the average rank in reading. Average ranks for reading and math remained fairly constant for the years 1993-95. The Tennessee Value Added Assessment System (TVAAS) database was then used to evaluate the Challenge program. Class sizes of about 1:15 in the Challenge systems accompanied achievement results in reading and mathematics that paralleled those predicted from the STAR experiment. The TVAAS database offers a reasonable way to monitor Challenge-system progress. Six tables are included. Appendices contain statistical data and a summary article on the TVAAS. (Contains 35 references.) (LMI)

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Analysis of Policy Application of Experimental Results: Project Challenge*

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ABSTRACT

"ANALYSIS OF POLICY APPLICATION OF EXPERIMENTAL RESULTS",
Charles M. Achilles, E. Michigan Univ.
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In 1989-1990 Tennessee leaders funded 17 school districts to apply results of STAR, a longitudinal experiment causally linking class size and student achievement. Researchers have studied Project Challenge (1989-1995) by analyzing the statewide rankings of the 17 (now 16) participating systems.

Reduced class sizes (1:15) have shown positive results in Challenge counties (n=17) as shown by mean ranks on pupil scores in Reading and Math of the Tennessee Comprehensive Assessment Program (TCAP) at grade two of: 99 (Reading) 85 (Math) in 1992, to 79 (Reading) 57 (Math) in 1993. Tennessee has 138 systems, so a rank of 69 is average. Challenge systems (collectively) were below average in 1990; by 1993 they were above average in math and 20 ranks closer to average in reading. Since by 1993 students in grade two would have had all three years of treatment (1:15), one would not expect major gains in later years. That was substantiated as the average ranks for reading and math remained fairly constant, 1993, 1994 and 1995.

After finding virtually identical results using Challenge and Tennessee Value Added Assessment System (TVAAS) analyses of Challenge, researchers suggested using the TVAAS database to evaluate Challenge as it will offer options for expanded analyses.

Class sizes of about 1:15 in Challenge systems accompanied achievement results in reading and math that paralleled those predicted from the STAR experiment. This application of research results seems justified. The TVAAS database offers a reasonable way to monitor Challenge-system progress.

The paper also contains a fairly detailed Bibliography about Project STAR and other related class-size studies in addition to the References.

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Analysis of Policy Application of Experimental Results: Project Challenge

Introduction

Some Background and Context

In 1985 legislators and policy persons in Tennessee (TN) planned to set class-size policy for early elementary grades. Before doing that they reviewed the extant? literature and found that there were no definitive answers about class size and pupil outcomes. They passed legislation and appropriated funds for what became known as Project STAR (Student-Teacher Achievement Ratio). The mandate for STAR was to determine the effects of small classes (a ratio of about 1:15) on pupil achievement (test results) and development in early primary grades (K-3).

Project STAR was a statewide, longitudinal experiment employing strict controls, random assignments of pupils and teachers, two treatments (1:15 and 1:25 with a full-time teacher aide) and a control condition (1:25) using an in-school design. There were about 100 classes of each condition during each of the study's four years. Students entered in K (1985-1986) and remained in their assigned class-type for grades K-3 (1985-1986 to 1988-1989). Random replacement was used if students moved or entered STAR Schools. Students took the Standard Achievement Tests (SAT) as the Norm Referenced Test (NRT) and Tennessee's Basic Skills First (BSF) as the Criterion-Referenced Test (CRT) geared to the objectives of the TN curriculum. Researchers collected much data on pupils, teachers, principals, schools, districts, etc. Although STAR began with about 7100 pupils, by the end--due to mobility--about 10,000 pupils were included in the database.

The TN legislature and State Department of Education provided funds to track STAR pupils. They are in grade 9 (1994-1995) to analyze the residual benefits of an early small-class start in school. This continuing study, conducted by the Center of Excellence at TN State University, is called the Lasting Benefits Study (LBS). Plans are to follow students academically until graduation from high school. After graduation researchers hope to study various education, work, and social adjustment factors.

In 1989-1990, using funds formerly to support STAR, the state established Project Challenge in 17 (by 1992-1993 only in 16) of TN's poor and educationally low-performing counties. The funds were used for across-the-board class-size reduction in grades K-3 to about 1:15. There was no specific research or evaluation design for Project Challenge (although the state did want some assessment or evaluation). All schools in the counties with grades K-3 were eligible to participate in Challenge. Thus, Challenge was really a limited (17 counties)--but inclusive in the affected districts--policy application of the positive results derived from the STAR experiment.

Project STAR did find a substantial class-size effect, with small class(es) exceeding both regular (R) and regular/aide (RA) classes on all measures by some .50 to .65 standard deviation units (Effect Size, or ES). [Detailed results appear elsewhere; e.g., Achilles, Nye, Boyd-Zaharias, Fulton and Cain, 1994; Achilles, Nye, and Bain, 1994; Achilles, Nye, Boyd-Zaharias, and Fulton, 1993; Finn and Achilles, 1990; Finn, Achilles, Bain, Folger, Johnston, Lintz and Word, 1990; Word, Johnston, Bain, Fulton, Boyd-Zaharias, Lintz, Achilles, Folger and Breda, 1990.]

The LBS has been evaluated and reported at least minimally; e.g., Finn, Fulton, Boyd-Zaharias and Nye, 1989; Nye, Boyd-Zaharias, Fulton, Achilles, Pate-Bain, 1991, 1992, 1993, 1994. Some added studies using the STAR database have also been reported; e.g., Finn and Cox, 1992; Boyd-Zaharias, 1993, etc. Results of the class-size intervention have been substantial,

especially in controlled studies. The question now seems to be "What is the success in using class size as an intervention to increase pupil achievement on a wide scale?"

Project Challenge

Initial Evaluations*

Project Challenge began in 1989-1990, and in TN the first state-wide testings occurred at grade 2, using the new (begun in 1989-1990) Tennessee Comprehensive Assessment Program (TCAP), which is a combination of NRT and CRT measures. Thus, the Spring 1990 testing used grade-2 results of the new TCAP and meant that the "baseline" measure for the Challenge comparisons really incorporated one year (grade 2) of small-class treatment in Challenge systems. Researchers chose this option over trying to determine comparability of data from the Stanford Achievement Test (SAT) used before 1989-1990 and the TCAP used in 1989-1990 and later years.

Based on STAR results, researchers expected that the grade-2 test results would improve as future cohorts of students who were tested in grade 2 experienced more years of reduced classes (up to 3 years, including grades K, 1, and 2). The grade/test sequencing appears in Table 1 and shows how each subsequent year would influence the length of time a student could be in

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* Material is substantially the same as presented in Achilles, Nye, Boyd-Zaharias, Cain and Fulton (1994, August). Project Challenge Addendum. Nashville, TN: Center of Excellence for Research in Basic Skills, TN State University. Unpublished manuscript.

Challenge before the test at grade 2 (or tests at grades 3 or 4 in later years as data became available).

Table 1 About Here

Staff at the Center of Excellence (COE) for Research in the Basic Skills at Tennessee State University worked with personnel at the Tennessee State Department of Education (SDE) to "track" and evaluate student academic progress in Challenge. Personnel at the COE used published data and data provided by the SDE for this purpose. Reports have been provided each year (Nye, Achilles, Boyd-Zaharias, Fulton, 1991, 1992, and 1993) and articles discussing early results have appeared elsewhere (e.g., Nye et al., 1993, 1994; Achilles et al., 1993). Since no funds were provided for added testing, etc., the Challenge evaluation used only the reading and math scores that students achieved on the TCAP each year. Data for comparison were the average rank each year of the Challenge systems (n=17 in 1989-90, 1990-91, 1991-92, 1992-93, and n=16 in 1993-94 and 1994-95) among the 138 Tennessee systems, so that the rank of 69 would be average. (For comparability, n=17 is maintained in this paper although one system has dropped from Challenge.) Rankings were used to suggest Challenge's progress in replicating STAR to achieve higher scores through class-size reductions in the elementary grades (especially grades K-3). There was no attempt before 1994-1995 to verify the actual class sizes used in the Challenge systems. The Project Challenge reports (1990-1994) were just gross indicators of achievement test outcomes.

Refining The Challenge Database

By 1992-1993, better test data were becoming available statewide; these data could be used in Challenge reports with no added testing. Tennessee policy makers had initiated the "Sanders Model" as a way to track student achievement. These data could be used to analyze district, building and even teacher successes as related to student test outcomes. In this process an individual student data file of annual test results on the TCAP is constantly being built and updated. This model is called the Tennessee Value-Added Assessment System or TVAAS, and data are now (1995) available for pupils in grades 2-8. (Appendix A provides a brief description of TVAAS.) The data can be aggregated at the classroom level, and the number (n) of pupils tested each year provides an indicator of class size. (This may not be the number of students regularly in class for instruction as some students may miss a testing.) In future Challenge reports, more detailed analyses of the Challenge class-size initiative will be provided by including class-size estimates based on the (n) for each testing.

Since TVAAS was a potential new database for Challenge analyses, first steps were 1) to develop a baseline of Challenge results using the TVAAS database for 1990-91, 1991-92, 1992-93, and 1993-94 to check the transition to TVAAS from the state-provided rankings used in the early Challenge reports and 2) to compare original Challenge results with the TVAAS database results. The next step will be to use the TVAAS database each year to employ detailed analyses that are possible with that database, if the results of 1 and 2 (described above) warrant the changeover.

Project Challenge and TVAAS

The TVAAS is a complex "mixed model" statistical process that considers a large number of variables. Primarily, the model compares the gains by students in Tennessee to the national norm

gain so that a "score" of 1.0 indicates that the Tennessee student (or class or school, depending on a unit of analysis) made a mean gain on the year being analyzed that was equal to the national norm gain. Thus, using TVAAS data, it is possible to rank not only the attained average scores (by system, or by school, or by classes), but also the equivalent mean gain (compared to the national norm gain). [When a state mean gain is computed, it is possible to rank each system in the state each year (at any grade level) on each system's mean gain.]

This present analysis extends Challenge Reports (Nye et al., 1991, 1992, 1993) by using TVAAS data to compute system mean scores and the rank of those mean scores by grade (2, 3, 4) for years 1991, 1992, 1993 by two test outcomes (reading and math) on the TCAP. Details of the TVAAS analysis are provided in Appendices: Appendix B shows the ranks based on system mean TCAP scores and also the ranks based on each system's mean gains. Those data are then transferred to Tables 2 and 3 to show similarity using two databases.

Tables 2 and 3 show the average ($\bar{x}$) rank of Challenge systems (n=17) among the 138 Tennessee systems for reading and math for the years and grades indicated, as well as the ranks based on mean gain (grade 3 and grade 4 and cumulative for grades 3 plus 4) among the state's systems.

Some STAR Results Relative to Challenge

Greatly simplified, STAR results were greatest for the 1:15 pupils at grades K and 1, with some tapering off of additional gains in grades 2 and 3. Using this as a guideline, we might expect Challenge (TCAP) results to be greatest once pupils who experienced their K-1 years in 1:15 classes had reached the grade levels (2, 3, 4) where they are tested. STAR results suggest that the 1:15 condition was primarily a preventive and not a remedial effort and that it was a facilitative variable -- it should let teachers do different things to help pupils succeed than they can do in 1:25

classes. This idea is borne out in efforts such as "Reading Recovery" or "Success for All" where improved and intense instruction or extra interventions are employed for small groups of pupils at an early time in the schooling process. Thus, we might even expect improved Challenge results where and when the teachers begin using instructional methods and materials appropriate for smaller classes or groups. Additionally, the STAR researchers suggested that as a treatment, the 1:15 experience occurs once (when the pupil enters the 1:15 environment) and then is continued. That is, the 1:15 is a treatment when it first happens, and that is when (comparatively speaking) most changes should be evident in test results. Since Tennessee did not test in K and 1, perhaps evidence of major Challenge-initiated gains has been lost with no testing until grade 2. Finally, there is no true baseline using TCAP, since the first year of TCAP testing at grade 2 occurred in 1989-1990 after pupils in grade 2 had already been in 1:15 for one year (grade 2). Appendix B also shows the TCAP analysis for Challenge systems using the state-supplied aggregate ranks from 1989-1990 through 1992-1993.

Preliminary Analysis of TVAAS Data: Tables 2 and 3

Given the above information, the TVAAS data in Tables 2 and 3 are instructive. For example, in Table 2, Grade 4 mean score ranks are consistently below the state average of 69, an expected event since Grade-4 pupils had very little (or no) exposure to 1:15 at testing in 1990, 1991 and 1992 and especially since they had no exposure to 1:15 in grades K or 1, years of greatest gain for class-size effect, as seen in Project STAR.

Data for grades 2 and 3, however, seem to show the "expected" impact of 1:15. In math from 1991 to 1993 the Grade-2 ranks (rounded) go from 71 (below state average) to 57 (above the average of 69); in reading the Grade-2 ranks go from 88 (below the state average of 69 by 19 places) to 79 (or below the state average by only 10 places).

Data in Table 3 show that the mean ranks of Challenge systems (1991-1993) on grade 3 TCAP scores and the cumulative ranks for grades 3 and 4 scores are at or above the TN mean, and that grade 4 (as expected) results are below the state average (grade 4 pupils had no 1:15 treatment by 1993).

Tables 2 and 3 About Here

Table 4 shows the mean gains for 1994 and 1995 for grades 3, 4, and 5 and the cumulative gains (3-5) at each testing. The drop in the rankings between grades 3 (and of 1:15) and 4 may reflect the "fade" that was also found in STAR. The systems, however, did not drop to pre-Challenge levels (see Appendix B). Since pupils were not in the treatment (1:15) one might expect that non-treatment scores would not reflect the same positive results as when students were in the 1:15 conditions. This is the case.

Prior Challenge Ranks vs. TVAAS Ranks

A comparison of Challenge results based on TVAAS ranks and the ranks produced by the grouped TCAP data provided to the Challenge researchers show considerable similarity. Data for comparisons discussed here are ranks from Nye et al. (1993, p. 10) for the 1991-1992 testings at Grade 2 as shown in Table 3. These results (see Table 5) show that the TVAAS rankings are about 4 places (3.8 in math and 3.7 in reading) better than the prior Challenge reports using less precise data (Nye et al., 1993, p. 10) that were availble at the time. When the re-analyzed data were available (1995), these differences were 1.9 in math (59.5-57.6) and 1.7 in reading (86.9-

85.2), with both TVAAS rankings slightly better than the prior computation using state-supplied data. Based on this similarity, it seems appropriate for Challenge researchers to continue to use the TVAAS database as it is more detailed and as prior results compared using the two databases are essentially the same. Use of the TVAAS database will help Challenge researchers improve the assessment of Challenge results. The TVAAS database is updated each year based upon new data, so there may be small changes in ranks depending upon the year that the rank was computed. (An example is in Tables 5 and 6.)

Table 5 About Here

TVAAS Information on Mean Gains

The TVAAS information on mean gains for the Challenge systems is less clear than the results based on ranks, and there are no prior Challenge reports to use as comparisons for mean gains (Table 3). Since the mean gains are based on a gain from one year to the next and since the first testing on the TCAP is in Grade 2, there can be no mean gain until grade 3 (gain from Grade 2 to Grade 3). The mean gains have more meaning and are more reliable after there are several data points for computation and comparison for each individual in the database. A system's ranked mean gain is a comparison of how well, among Tennessee's 138 systems, that system did in terms of achieving the national norm gain for that year. Thus, the average gain for the 17 Challenge systems (Table 3) of 49.7 for math and 44.2 for reading in Grade 3 (1991 testing) is for pupils who, by 1991, could have had 1:15 treatment for 2 years (grades 2 and 3; Table 1). These ranks are considerably better than the state average of 69 and show that on average, Challenge systems

were gaining more compared to the national norm gain than was the average ($\bar{x}$=69) Tennessee system. (But, they did have farther to go at the start!)

Some of this improvement in ranking begins to taper off in 1992 and even more so in 1993, especially in math. In reading in Grade 3 the Challenge systems exceeded the state average, but there is a drop in Grade 4 in math. This suggests added research, such as a check into the curricula and the materials (especially the math manipulatives and the special programs) available in these poor counties to support advanced math concept mastery. These issues, and issues such as the teachers' preparation levels and comfort levels with advanced math, will need further exploration as a way to help researchers understand the declining mean gains in Challenge systems, in math in Grades 3 and 4.

Table 6 shows the TVAAS grade-2 results (all pupils had the full 1-15 treatment and were still in 1:15 at testing) for the average rank ($\bar{x}$) and the mean gain for Challenge systems. Both ranks and gains are at or below the state average of 69 in most cases. The difference between results in Tables 4 and 6 reflect the difference when the student is in 1:15 and after a pupil leaves 1:15. Results were generally parallel findings both of STAR and of LBS.

A review of the class sizes in Project STAR showed that as STAR progressed, some classes became "out of range" or there was a "bunching" of small (S) classes at the large end of (S) -- e.g., pupil n=16, 17 or even 18 and a "bunching" of regular (R) classes at the small and of (R) -- e.g., pupil n=22 or 23, rather than 25-27 or so. (See Appendix C.) Future use of TVAAS data can help Challenge researchers sort out more specifically the class-size impact by providing more precise data on the numbers of pupils in classes, and the tracking of pupils through the grades.

Conclusions

The expanded data available (TVAAS) support the positive effects of 1:15 in the poorer counties in Tennessee, at least through the 1995 testings in grades 2, 3 and 4. This report did not add any insights into results related to actual class sizes (researchers assumed the 1:15 conditions generally throughout Challenge systems). The availability of TVAAS data should help researchers prepare more detailed reports by using class-level results compared by class size based on the actual number of pupils tested. Results support the changing from state-reported aggregate data to the TVAAS database as the differences (Grade 2, 1991-1992) in ranks using the two databases were less than 4 places.

Because the TVAAS data began in 1990-1991, they do not show the considerable gains from 1989-1990 testings in the earlier Challenge reports (e.g., Nye et al., 1993, p. 10). However, similarities shown between TVAAS data and prior Challenge documents could be verified if TVAAS data were available for the earlier years. There seems to be little reason to doubt that reduced class sizes (1:15) in early primary grades (K-3) have assisted reading and math achievement gains in the Challenge school systems. This observed gain would be expected based on STAR results, and the "tapering off" of results in grades 3 and 4 can be substantiated in part by both STAR and LBS results to date.

The expanded data from TVAAS into grades 3, 4 and 5 and the computations available on test-score cumulative gains for selected grades make the TVAAS a valuable and useful way to analyze Challenge and to identify areas for future research. Researchers need now to analyze the "fade" found in Challenge and compare it to LBS results, both for the amount of the "fade" and to determine at which grade the "fade" is most prevalent. Review of TVAAS data on Challenge systems will open added areas for inquiry.

Project Challenge is one example of state-level policy persons accepting and using substantive experimental research results as the basis for program decisions. Indeed, class-size reduction can be an expansive option. [There are indications that it is not really an expensive policy option if such costs from grade retention, special education placement, future remediation, are accounted for as well as the increased participation in schooling (Finn and Cox, 1992; Finn et al., 1989) and other social benefits (e.g., Weikart, 1989) are seriously taken into the finance and performance equation.]

Evaluation of the Challenge initiative is providing evidence that the broad-scale policy implementation of research results is working well even in poor counties. Use of expanding databases (e.g., TVAAS) developed for other purposes than the direct evaluation of a project can be helpful in reducing evaluation costs and in improving the scope of low-cost policy evaluations.

Author Notes

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C.M. Achilles, Professor of Educational Leadership, Eastern Michigan University, Ypsilanti, was a principal investigator on Project STAR (1985-1990) and is a consultant working with the Center's Lasting Benefits Study (LBS), Project Challenge, and continuing analyses of STAR data (1990-present). Barbara Nye is Executive Director, Center of Excellence for Research in Basic Skills, Tennessee State University, 330 10th Avenue North, Nashville, TN 37203-1591, where the other authors (J. Boyd-Zaharias and D. Fulton) are staff members who have worked with the various class-size initiatives in Tennessee since 1986. Those initiatives are STAR, LBS, and Challenge.

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Tables

Table 1

Summary of Testing for Challenge Systems (1989-1990 to 1994) with Testing at Grades 2, 3, and 4 to Show How Long a Pupil Could Have Been in 1:15 at the Time of Testing

Grade Tested, and Years of 1:15 Participation Possible			
Year Tested	Grade	YRS in 1:15*	Grades in 1:15
1990	2	1	2
	3	1	3
	4	0	0
1991	2	2	1 & 2
	3	2	2 & 3
	4	1	3
1992	2	3	K & 1 & 2
	3	3	1 & 2 & 3
	4	2	2 & 3
1993	2	3	K & 1 & 2
	3	4	K & 1 & 2 & 3
	4	3	1 & 2 & 3
1994 and	2	3	K & 1 & 2
later years	3	4	K & 1 & 2 & 3
	4	4	K & 1 & 2 & 3

* This presumes the maximum possible that a pupil could have experienced the 1:15 condition by the time and grade of testing. Note that in Tennessee, kindergarten has not been required until 1994.

Table 2

Mean Scores (Reading and Math) of Challenge Systems (n=17) Ranked by Grade (2, 3, 4) for 1991-1993. (Tennessee had 138 systems so state $\bar{x} = 69$)

	1991			1992			1993		
	($\bar{x}$) rank by grade			($\bar{x}$) rank by grade			($\bar{x}$) rank by grade		
Subject	2($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)	2($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)	2($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)
Math	71.1	65.2	80.8	55.7	57.4	77.8	56.5	65.9	82.2
Reading	88.2	88.9	102.0	83.2	85.6	91.3	78.5	77.3	102.0

Table 3

Mean Gains (TVAAS) in Reading and Math of Challenge Systems (n=17) Ranked by Grade (3 and 4) and Cumulative (Grades 3 plus 4) for 1991-1993. (Tennessee had 138 systems so state $\bar{x} = 69$)

	1991			1992			1993		
	($\bar{x}$) rank by grade			($\bar{x}$) rank by grade			($\bar{x}$) rank by grade		
Subject	3($\bar{x}$)	4($\bar{x}$)	3&4($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)	3&4($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)	3&4($\bar{x}$)
Math	49.7	80.9	64.2	59.9	82.4	72.4	79.6	99.0	96.9
Reading	44.2	77.4	53.7	66.0	75.4	71.9	56.9	82.6	64.5

Table 4

Mean Gains (TVAAS) in Reading and Math of Challenge Systems (n=17) Ranked by Grades (3, 4, 5) and Cumulative (Grades 3-5) for 1993-1995

	1994				1995			
	($\bar{x}$) rank by grade			Cum.	($\bar{x}$) rank by grade			Cum.
Subject	3($\bar{x}$)	4($\bar{x}$)	5($\bar{x}$)	3-5($\bar{x}$)	3($\bar{x}$)	4($\bar{x}$)	5($\bar{x}$)	3-5($\bar{x}$)
Math	78.8	91.1	74.2	91.5	83.3	87.5	85.1	93.7
Reading	62.1	91.5	82.5	83.1	63.4	101.0	83.2	87.6

Table 5

Comparisons Using 1991-1992 Grade-2 Results in Reading and Math of TVAAS Data and Prior Challenge (Nye et al., 1993) Reports of Challenge Systems (n=17) on ($\bar{x}$) Ranks, and Showing 1992-1993 TVAAS Results

	Grade 2 ($\bar{x}$ Rank)			
	1991-1992 (A)	1991-1992 (B)	Difference:	1992-1993
Subject	TVAAS	Nye et al (1993)	A - B	TVAAS
Math	55.7	59.5	-3.8	56.5
Reading	83.2	86.9	-3.7	78.5

Table 6

TVAAS Display (1992-1995) Grade-2 Results in Reading and Math, Challenge Systems (n=17) on ($\bar{x}$) Ranks on the Gain Ranked (Grades 2 to 3)

Grade 2 ($\bar{x}$ Rank) and Gain (2-3)

	1991-92*		1992-93*		1993-94*		1994-95	
	($\bar{x}$)	Gain	($\bar{x}$)	Gain	($\bar{x}$)	Gain	($\bar{x}$)	Gain
Math	57.6	62.1	55.3	81.2	55.8	78.8	54.5	83.3
Reading	85.2	66.2	77.5	56.3	78.8	62.1	73.5	63.4

* Slightly different from Table 5 data due to the constant corrections made in data and the analysis. Note that with the correction (1995) there is less difference (A-B) in Table 5 above for 1991-92.

Appendices

Appendix A

An Overview of the:

Tennessee Value-Added Assessment System (TVAAS)

with

Answers to Frequently Asked Questions

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APPENDIX A

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Tennessee Value Added Assessment System

The fundamental objective of K-12 education is to provide for academic growth for each student consistent with his or her innate abilities within a total curricular framework. To achieve this objective, appropriate growth must occur each academic year. If a quantitative measure of academic growth is available for each student, then a base is formed for an assessment system which will determine progress toward the fundamental objective of providing sustained academic growth for each student.

In 1990, the Tennessee Department of Education initiated the Tennessee Comprehensive Assessment Program (TCAP) to provide information on student academic progress in Tennessee. Since each student in Tennessee in grades 2-8 is tested annually, scores in each of five subjects are available as input into a system for objective assessment based upon measures of growth from this testing process.

Since many factors affect rates of student learning, some of which are outside the purview of the educational community, an effective assessment system must be able to distinguish factors which can be controlled within the educational process from other influences. The Tennessee Value-Added Assessment System (TVAAS), often referred to as the Sanders Model, was developed to provide this capability.

What TVAAS is:

TVAAS is a statistical process which provides measures of the influence that school systems, schools, and teachers have on indicators of student learning. Initially, TVAAS will furnish this information on the system level for each school system in Tennessee for grades three through eight in math, science, reading, language, and social studies by using the scale scores from the Tennessee Comprehensive Assessment Program (TCAP). TVAAS will be extended to cover grades nine through twelve when subject matter specific tests that can provide comparable data for these grades have been developed and validated. TVAAS is mandated by the Educational Improvement Act which took effect July 1, 1992.

TVAAS is based upon work completed by Dr. William L. Sanders and Dr. Robert A. McLean using data from second thorough sixth grade students from three systems: Knox County, Blount County, and Chattanooga City. Their studies, based upon 65,000+ student records, yielded six primary findings:

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1. There were measurable differences among schools and teachers with regard to their effect on indicators of student learning.

2. The estimates of school and teacher effects tended to be consistent from one year to the next.

3. Teacher effects were not site specific, i.e., a gain score could not be predicted by simply knowing the location of the school.

4. Student gains were not related to the ability or achievement levels of the students when they entered the classroom.

5. The estimate of school effects was not related to the racial composition of the student body.

6. There was very strong correlation between teacher effects as determined by the data and subjective evaluations by principals and supervisors.

Rigorous statistical theory underpins the TVAAS model. Sanders and McLean demonstrated that Henderson's mixed-model methodology (for an introduction to this methodology see McLean, Sanders and Stroup, 1991), when applied in the context of educational outcome assessment, would eliminate most of the statistical problems previously identified as impediments to the use of student achievement data as part of an assessment process (McLean & Sanders, 1984). Thus, by basing TVAAS on statistical mixed model methodology, unbiased estimates of the influence of teachers, schools, and school systems on student learning rates can be obtained, even when extreme differences exist in students' environments and in students' assignments to teachers. The robustness of the TVAAS model has been confirmed using computer simulations to evaluate "worst case scenarios".

How it Works:

TVAAS analyses the scale scores students make over a period of three to five years on the norm-referenced items on the TCAP. Unlike stanines or percentiles that are used to rank students against their peers, the scale scores indicate a student's current level of attainment in a subject. Whereas stanines and percentiles tend to remain relatively constant, scale scores are designed to increase from year to year as the student learns.

The pattern of the scale scores over the child's school career forms a profile of academic growth. Regardless of the level at which students enter the classroom, if they make progress, their academic gains will be

reflected in increased scale scores. By statistically aggregating the "dimples" and "bubbles" in these curves over a population of students, the influence of school systems, schools, and teachers can be fairly estimated. To achieve this, the solutions to tens of thousands of simultaneous equations is usually necessary. As an integral component of TVAAS, a software system to accomplish this enormous computing task has been developed.

A data base containing the merged records of all students in Tennessee who have taken the TCAP tests during the past three years has been constructed. At present (1992), it contains more than 1.6 million student records. This number will continue to grow over time and will enable continued tracking of the academic growth of each student.

The Educational Improvement Act (EIA) mandates that school system effects on the educational progress of students for grades three through eight, as determined through the use of TVAAS, will be reported for systems state-wide no later than April 1, 1993. This report will be available to the public and will be updated annually.

The EIA sets July 1, 1994 as the deadline for issuing the first set of reports on individual school effects. This set of reports will also be available to the public and will be revised on a yearly basis.

The individual teacher effects for teachers of grades three through eight are to be reported to the teacher, appropriate administrators, and school board members no later than July 1, 1995, according to the EIA. These reports relating to the influence of individual teachers on the rate of student learning will not be available to the public. Reports on all levels will be based on at least three years of data and no more than five years of data.

The following are some of the questions that educators ask about TVAAS:

There are so many things going on in my students' lives, some of them traumatic. How much influence do I have on their progress, anyway?

The child you receive this year tends to have the same learning ability, the same environment, the same emotional stability as s/he had in the past unless something traumatic happens -- drugs, serious illness, divorce of the parents, and so forth. When such a trauma occurs, students' learning curves can change dramatically. A "learning curve" does not refer to a smooth, elegant line under the best of circumstances. Rather, it is a line marked with "bubbles" and "dents", denoting a child's variable progress

through academic life. If recovery takes place, this curve will return to its previous trajectory, with a dent marking the troubled time in the child's life. If, however, recuperation does not occur, the reference curve itself changes. In other words, a very personal experience is reflected in the statistical profile of the child. What this means to a teacher is that the child's new learning profile will be the base from which that child's contribution to the over-all effect will be determined. Therefore, an individual teacher or school does not have to be concerned about potential bias in the estimated effects caused by an abrupt change in the growth pattern of individual students.

If I have a class of third graders who come to me reading on a first grade level, how can I possibly show up well on an assessment, no matter what I do?

TVAAS is especially sensitive to what level a student has achieved in a subject area when you see the child for the first time. If your students make progress, they will show a positive gain in their scores on the TCAP norm-referenced items. Whether the scores reflect a growth from a sixth to a seventh grade level or from a second to a third grade level, it is still a positive gain and it shows that your teaching has been effective.

Won't students who have less ability make smaller gains than bright students? Do you expect a child with an IQ of 80 to gain as much as a student whose IQ is 120?

TVAAS determines the gain each group of students can be expected to obtain by considering their prior history of achievement. Thus, if children are taught in a manner consistent with their current level of attainment, then appropriate gains are achievable.

I serve a transient population, mostly children of military personnel. How can my teaching be assessed if half my students enter or leave sometime during the school year?

Only scores of students who have been present in your class for at least 150 days of the school year will be used by TVAAS. The attendance figure will be the attendance of the child for the year and will be entered at the end of the school year, even though the child will probably be tested sometime before the 150th day of the school year.

The question of transient students was one of the very first problems that the developers of TVAAS addressed. Because of the ways in which teacher effects and student scores interrelate with one another, it is possible to take advantage of the "shingling" phenomenon. A explanation of

"shingling" is that the data of students a teacher has instructed in the past overlap with that of students the teacher is now teaching. In addition, data gathered on students before they come to a given teacher and the performance of this teacher's students under subsequent teachers furnishes a detailed picture of the students' progress, even if a large proportion of the students move in or out of the system in any given year. Thus, by utilizing the overlap the whole "roof" can be covered.

Why are you using the norm-referenced questions to gather the scores for TVAAS? Some of those questions are much too hard for my students. Wouldn't it be better to use the criterion-referenced items?

Norm-referenced items cover a range from substantially below the grade level on which the students are being tested to substantially above that level. Your students aren't supposed to know the answers to all of the questions. This is why these scores can assess gains even for students functioning above or below the grade to which they are assigned.

The norm-referenced questions on the TCAP have been validated against a national sample of children in order to determine what a child on a certain grade level is expected to know. The gains that are normal from year to year have also been validated on a national sample. The developers of TVAAS have found that, generally, Tennessee's students achieve scores and gains that closely approximate the national averages.

On the other hand, criterion-referenced items can only indicate whether or not a student has learned a specific piece of information. This is important information, but it doesn't reveal knowledge about the gains a student has made from one year to the next. Assume that you teach fourth grade, and you have a student who is two years behind in math. You may teach this student a great deal in a year's time, and yet s/he may still not be able to answer the criterion-referenced questions for the fourth grade. The improvement this student has made could not be detected by criterion-referenced items, but progress would be quite evident in performance on the norm-referenced items.

My students are mostly from the inner city. Won't that make a difference in their gain scores?

The pilot studies revealed no relationship between the racial composition of student body and gain scores. Whether a school was an inner city school or a suburban one was also found to be unrelated to the gains students made.

Subsequent analysis of data from the TCAP data base does indicate that measurable differences in mean gains do exist among school systems and among schools within school systems. At most, only a small portion of these differences can be attributed to socio-economic factors.

I am an art teacher. How will I be assessed? What about librarians? guidance counselors? physical education teachers?

Any subject with a curriculum to which scale scores can be applied could be evaluated by the TVAAS. However, there are no plans at present to develop tests for these special areas in grades 3 through 8.

I have honor students all day. Their scores are already very high. How can you tell whether I've made a difference to them?

Analysis of scale scores indicate that there is enough stretch in the test to accommodate our top students. Even among gifted learners, perfection is extremely rare. When it does occur, its effect on school and teacher gains is trivial.

If my effectiveness is going to be judged by how well my students do on the TCAP, it really makes more sense to concentrate on teaching to the test than on trying to cover the whole subject, doesn't it?

The items which will be used by TVAAS must be "fresh, non-redundant equivalent tests, replaced each year"[EIA, section 4(g)(7)]. Each TCAP test represents a carefully constructed "sample" of items over a broad domain of possible items within each discipline. Since most of the items will be new each year, it will be extremely difficult to predict what the specific items will be for any given year. Thus, teachers measured to be most effective will be those who teach subjects holistically rather than teachers who concentrate on isolated facts and skills that have been tested for in the past. Teaching integrated subject matter is consistent with research on how students learn best and is, therefore, also consistent with good test scores.

What if a teacher gets a copy of the test and teaches it to fifth grade students? Won't that mean that student gains in the sixth grade won't look very good--and neither will their teacher?

First of all, test security is of great importance, and the legislature was fully aware of this fact. The EIA sets forth the following sanctions in section 4(g)(9):

> Any person found to have not followed security guidelines for administration of the TCAP test, or a successor test, including making or distributing unauthorized copies of the test, altering a grade or answer sheet, providing copies of answers or test questions, or otherwise compromising the integrity of the testing process shall be placed on immediate suspension and such actions will be grounds for dismissal, including dismissal of tenured employees. Such actions shall be grounds for revocation of state license.

Furthermore, it is possible through analysis of the data to recognize specific situations in which the test has been compromised. TVAAS is designed to "kick out" suspicious data for further examination. Additionally, the statistical processes which undergird TVAAS assure that a specific effect will not be unduly influenced by undetected inappropriate prior behavior. This has been confirmed by computer simulation which documents the robustness of TVAAS.

How can an assessment system that's based on test scores encourage innovation in the classroom?

TVAAS was conceived as a method of estimating the academic growth of each student over his or her school career in each subject. It does not suggest or prescribe a particular method for encouraging this growth. How you help your students learn is your decision. Typically, students perform well on standardized tests whenever good teachers, day after day, promote scholarship and make sound instructional decisions.

References:

McLean, R. A., and Sanders, W. L. (1984), *Objective Component of Teacher Evaluation--A Feasibility Study*, (Working Paper No. 199), Knoxville, TN: University of Tennessee, College of Business Administration.

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Appendix B

Summary of Change in Ranks, 1989-1990 to 1992-1993, for Reading and Math. State of Tennessee Second-Grade TCAP Results for 17 Challenge Systems Using the State-Provided Aggregate Data (1989-1992) and TVAAS (1993)

Tennessee Challenge Systems (N=17)	TCAP Scores: Grade 2							
	Reading (TOT)				Mathematics (TOT)			
	89-90	90-91	91-92	92-93	89-90	90-91	91-92	92-93
Sum of Ranks	1681	1591	1477	1335	1448	1336	1011	961
-17	98.9	93.6	86.9	78.5	85.2	78.6	59.5	56.5
Differences 90-91								
Gain in Rank		+90				+112		
Average Gain		+5.3				+6.6		
Differences 91-92								
Gain in Rank			+114				+325	
Average Gain			+6.7				+19.1	
Differences 92-93								
Gain in Rank				+142				+50
Average Gain				+8.4				+2.9
Differences 90-93								
Gain in Rank			+346				+487	
Average Gain			+20.4				+28.6	

Note: State has 138 districts. Average rank is approximately 68. A Grade-One analysis (1992) shows both reading and math above the State average (56.8 and 62.8). Later analyses will be conducted on different grade levels and by using various sub-tests of TCAP.

Appendix C

Distribution of STAR classes by grade (K-3) by designation S (Small), R (Regular), and RA (Regular and Aide).

	K (n classes)			1 (n classes)			2 (n classes)			3 (n classes)		
	S	R	RA	S	R	RA	S	R	RA	S	R	RA
11										2		
12	8			2			3			2		
13	19			14			16			15		
A 14	22			18			27			17		
15	23		1	31			32			31		
16	31	1		16	1		29	1		31		1
17	24	4	1	33	1		19			27		
18		1	2	6	2		6			10	1	
B 19		7	6	3	4	3	1	3	3	5		4
20		6	6	1	10	6		2	1		9	13
21		14	12		18	18		7	11		11	12
22		20	20		27	15		23	21		13	16
23		16	21		19	20		20	21		10	14
24		19	14		16	11		22	25		15	14
25		6	6		7	9		9	15		16	15
C 26		4	3		5	9		6	7		5	12
27		1	6		2	4		4	1		5	8
28			1		1	2		1	0		2	6
29					1	2		2	2		2	2
30					1	1						
Total	127	99	99	124	15	100	133	100	107	140	90	107
	325			339			340			337		

A = range for (S); B = "out of range"; C = range for both (R) and (RA) classes.